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Forest Service

Northeastern Area

1984 Spruce Budworm Suppression Project On Passamaquoddy Indian Tribal Lands, Maine

Post-Treatment Evaluation

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Prepared by: IMANTS MILLERS AND DENNIS SOUTO; Entomologists,
Forest Pest Management, USDA Forest Service, PO Box 640,
Durham, NH 03824

SUMMARY

The Passamaquoddy Indian Forestry Department treated 23,852 acres in Indian Township and Lowelltown-Holeb Townships to protect spruce from spruce budworm damage. Dipel 6L was applied undiluted at 12 BIU's per acre using Snow Thrush aircraft equipped with Mini-Micronair (AU-5000) rotary atomizers. A small area in Indian Township was treated with Futura applied undiluted at 8 BIU's per acre.

In Indian Township, Dipel 6L and Futura were compared and no significant differences existed for budworm mortality, budworm survivors or defoliation (ANOVA, p=.05). Sprayed areas had significantly more budworm mortality (92 percent) and fewer survivors (63 budworms per 100 square feet of foliage) than unsprayed areas (82 percent budworm mortality and 260 budworm survivors per 100 square feet of foliage).

In Lowelltown-Holeb Townships, there was no significant difference in budworm mortality, budworm survivors or defoliation between areas treated with Dipel 6L and unsprayed areas.

INTRODUCTION

Based on a biological evaluation conducted in October 1983, the USDA Forest Service recommended as one of the alternatives aerial application of Bt on 14,000 acres in Indian Township and 8,500 acres in Lowelltown-Holeb Townships.[1/] The Passamaquoddy Indian Forestry Department (PFD) requested and received suppression funds to protect red spruce from spruce budworm defoliation. The PFD planned and carried out the suppression project on 15,865 acres in Indian Township and 7,996 acres in Lowelltown-Holeb Townships. The USDA Forest Service's Durham Field Office provided technical assistance to the PFD to implement and evaluate the suppression project. This report summarizes that evaluation.

APPLICATION

Both Bt insecticides were loaded directly from 55 gallon drums into the Snow Thrush spray aircraft (Precision Air, Foley AL) and dispersed through six Mini-Micronair (AU-5000) rotary atomizers per spray aircraft. The aircraft flew at 110 mph and 50 feet above tree tops.

Dipel 6L (Abbott Laboratories) was applied on 23,209 acres at 32 fl. oz./acre to give a dosage of 12 BIU's/acre. The boom pressure was 40 psi; atomizer blade pitch was set at 45°; and VRU's were set at 11. Swath width was 300 feet and the liquid flow rate used for calibration was 1.05 times faster than water (Abbott Laboratories, personal communication).

Futura (Biochem Products) was applied on 652 acres at 20.5 fl.oz./acre to give a dosage of 8 BIU's/acre. The boom pressure was 26 psi; atomizer blade pitch was set at 35°; and VRU's were set at 11. Swath width was 150 feet and the liquid flow rate used for calibration was 0.90 times slower than water (Biochem Products, personal communication).

A guide plane (Lincoln Air) equipped with a Loran C guidance system located swaths for the two aircraft spray team. A monitor (PFD) and spotter (Lincoln Air) observed all applications from a monitor aircraft and called booms on and off as well as observing team spacing, spray cloud behavior and weather.

The following weather guidelines were used to apply spray:

(1) drip dry foliage
(2) no rain forecast for four hours
(3) windspeed greater than 3 mph but less than 15 mph
(4) no inversion layers present below spray aircraft
(5) air temperature during spraying between 32°F and 80°F
(6) budworm feeding activity expected within 36-48 hours (temperature above 55°F).

[1/] Millers, I., D. Souto and L. McCreery. 1984 Spruce Budworm on Passamaquoddy Indian Tribal Lands, Maine. USDA Forest Service Northeastern Area, Internal Biological Evaluation Report. 20p.

Our target was to treat budworm populations in the peak of the fourth instar, using the Maine Forest Service system to determine larval instars (J. Connors, personal communication). Larval index in Indian Township on 6/4/84 (the first day of spraying) was 3.97. The larval index in Lowelltown-Holeb Township was 3.70 three days before spraying began. Spruce bud index was 1.0 in both Indian and Lowelltown-Holeb Townships when spraying began. In both areas, spraying was completed within two days.

EVALUATION

1. Sample Clusters

In Indian Township, 13 sample clusters were established in areas treated with Dipel 6L and five sample clusters were established in nearby unsprayed areas. In addition, six sample clusters were established in areas treated with Futura. Each sample cluster consisted of five dominant spruce trees. In Lowelltown-Holeb Townships, five sample clusters were established in areas treated with Dipel 6L and three sample clusters were established in nearby unsprayed areas.

2. Prespray Survey

Field crews collected one 18-inch midcrown branch from each sample tree three days or less before spraying. The branches were taken to the Passamaquoddy Laboratory in Topsfield and searched for budworm larvae.

3. Postspray Survey

Field crews collected two 18-inch midcrown branches from each sample tree in early July after larval feeding had ceased. In the Passamaquoddy Laboratory, budworms were counted and defoliation estimated. For each branch, 25 current shoots were rated in ten percent defoliation classes and these estimates were averaged to derive whole branch defoliation.

4. Spray Deposit Assessment

Midcrown twigs (about six inches long) were collected from each sample tree after the area was treated. Twigs were packaged in envelopes and taken to the Durham Field Office. In a transfer hood, 20 previous year's (1983) needles were removed from each twig and placed in petri dishes on tripticase soy agar. After incubating for 2-3 days, we determined the proportion of needles with Bt colonies. Sample Bt colonies were examined under a microscope to confirm the presence of Bt crystals. If any needles from unsprayed twigs had Bt colonies, then that cluster was deleted from the evaluation.

RESULTS

1. Indian Township

a. In areas treated with Dipel 6L, budworm populations declined from 990(+/-123) to 59(+/-14) budworms per 100 square feet of foliage for an average mortality of 93(+/-1.5) percent (Table 1). In areas treated with Futura, budworm

TABLE 1. SUMMARY OF SAMPLE CLUSTER DATA

TREATMENT	BUDWORMS/100 ft²/ Before Spraying	BUDWORMS/100 ft²/ After Spraying	PERCENT Mortality	PERCENT Defoliation	Needles with Bt Colonies
INDIAN TOWNSHIP					
DIPEL 6L	701	44	94	2	81
	268	22	92	3	23
	903	165	82	8	38
	1079	0	100	6	18
	1360	20	99	8	18
	909	9	99	2	-
	809	24	97	2	44
	684	59	91	8	-
	2090	39	98	6	2
	827	51	94	2	-
	754	94	88	5	-
	1419	122	91	14	-
	1067	124	88	8	-
Average[1]/	990+/-123	59+/-14	93+/-1.5	5.7+/-1.0	32+/-9.7
FUTURA	2065	20	99	6	39
	1127	40	96	5	41
	1348	136	90	20	16
	494	61	88	4	21
	568	103	82	8	30
	323	71	78	7	11
Average[1]/	988+/-269	72+/-17	89+/-3.3	8.2+/-2.4	26+/-5.0
CHECK	563	97	83	7	-
	2538	486	81	18	-
	1036	196	81	6	-
Average[1]/	1379+/-595	260+/-117	82+/-0.7	10.3+/-3.8	
LOWELLTOWN					
DIPEL 6L	983	22	98	7	38
	404	0	100	4	13
	602	0	100	4	13
	1279	150	88	16	8
	947	211	78	32	4
Average[1]/	843+/-154	77+/-44	93+/-4.3	12.6+/-5.3	15.2+/-5.9
CHECK	2577	143	94	25	0
	156	9	94	12	0
Average[1]/	1366+/-1210	76+/-67	94+/-0	18.5+/-6.5	

1/ Mean ($\bar{x}$) +/- standard error of the mean ($SE_{\bar{x}}$)

populations declined from 988 (+/-269) to 72(+/-17) budworms per 100 square feet of foliage for an average mortality of 89(+/-3.3) percent. Neither budworm mortality or budworm survivors differed significantly between areas treated with Dipel 6L and Futura (ANOVA, p=.05).

Combining the data for all sprayed areas, budworm populations declined from 989(+/-121) to 63(+/-11) budworms per 100 square feet of foliage for an average mortality of 92(+/-1.5) percent. In the unsprayed areas, budworm populations declined from 1379(+/-595) to 260(+/-117) budworms per 100 square feet of foliage for an average mortality of 82(+/-0.7) percent. Sprayed areas had significantly higher budworm mortality and less budworm survivors than unsprayed areas (ANOVA, p=.05).

b. Defoliation

Areas treated with Dipel 6L averaged 6(+/1.0) percent defoliation compared to 8(+/-2.4) percent defoliation for Futura-treated areas. This difference was not statistically significant. Combining the data for all sprayed areas, defoliation averaged 7(+/-1.0) percent compared to 10(+/-3.8) percent in unsprayed areas, but the difference is not statistically significant (ANOVA, p=.05).

c. Spray Coverage

In Dipel 6L clusters, 32 (+/-10) percent of the needles had Bt colonies compared to 26(+/-5) percent for Futura clusters (Table 1). Deposit assessment twigs were not collected from the Indian Township unsprayed clusters. However, two clusters were removed from the analysis because both clusters were located near spray blocks and possibly sprayed.

2. Lowelltown-Holeb Townships

a. Population Reduction

In areas treated with Dipel 6L, budworm populations declined from 843(+/-154) to 77(+/-44) budworms per 100 square feet of foliage for an average mortality of 93(+/-4.3) percent. In the unsprayed areas, budworm populations declined from 1366(+/-1210) to 76(+/-67) budworms per 100 square feet of foliage for an average mortality of 94(+/-0) percent. The differences between sprayed and unsprayed areas are not statistically significant (ANOVA, p=.05).

b. Defoliation

Defoliation averaged 13(+/-5.3) percent in Dipel 6L-treated areas compared to 19(+/-6.5) percent for unsprayed areas. The difference between sprayed and unsprayed areas is not statistically significant (ANOVA, p=0.05).

c. Spray Coverage

Treated clusters averaged 15 percent of the needles with Bt colonies. One check cluster had Bt colonies and we eliminated it from the analysis (Table 1).

DISCUSSION

1. Population Reduction

Budworm mortality was high in both sprayed and unsprayed areas. Normally, mortality in unsprayed areas is about 50 percent due to natural controlling factors such as parasites, predators and diseases. Recent investigations suggest that high budworm mortalities occur on spruce when spruce bud development is out of synchrony with budworm development (from discussions at the Red Spruce Protection Workshop at Bangor, ME, 10/23/84).

At the time of spraying, spruce buds were tight and probably unavailable to spruce budworm. This mortality factor would become important after the prespray survey and is not considered in our current survey methods.

2. Defoliation

Defoliation was low in both sprayed and unsprayed areas. The moderately high budworm populations did not cause the expected moderate to heavy defoliation. If heavy budworm mortality occurred before budmining, then more current foliage would be available for surviving budworms to defoliate -- and defoliation would be lower than expected. We suspect this happened in 1984. However, if budworm mortality occurred after budmining, then less current foliage would be available for defoliation by budworm survivors--and we would expect heavier defoliation. Our current defoliation estimates do not consider budmining.

3. Protection Benefits

Based on existing methods of measuring damage to spruce, treatment benefits are difficult to show for the third year in a row. Despite high budworm populations found from egg-mass surveys and overwintering larval surveys, prespray larval populations have been moderate. Similar populations on balsam fir have caused heavy defoliation. Even during the last three years, occasionally heavy defoliation of spruce has occurred in the vicinity of the Indian lands. However, expected defoliation in our unsprayed areas did not occur. Budworm mortalities were high in these unsprayed areas between the time of prespray survey and post-spray survey 3-4 weeks later. Less than one budworm per 18" branch survived even without spraying. Thus, even when benefits from the treatment can be shown statistically, the differences are not significant from a protection standpoint. Because similar situations have ocurred on lands protected by other jurisdictions, such as New Brunswick, State of Maine and private industrial companies, a workshop was held in Bangor, Maine, on October 23, 1984, to review the problems of spruce protection. The consensus was that research is needed in the biology of the budworm on spruce, how damage on spruce occurs and how to measure it, and where and how suppression treatments should be applied and measured. As a result, we do not recommend further suppression treatments on red spruce when budworm populations are similar to the past 3 years, until additional data shows the benefits of such treatments.

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Spruce Budworm on Passamaquoddy Indian Tribal Lands, Maine

Biological Evaluation Report

February 1985

Prepared by: DENNIS SOUTO, Entomologist; Forest Pest Management
USDA Forest Service, PO Box 640, Durham, NH 03824

ABSTRACT

Budworm and coneworm population levels are expected to be extreme and spruce defoliation heavy to severe in T4ND in 1985. Other Passamaquoddy ownerships should have low to medium population levels and light 1985 defoliation. Stand hazard rating is moderate in all areas but is the highest in T4ND and Indian Township.

Based on spruce budworm and spruce coneworm populations, and traditional assessment of expected damage, we recommend treatment to prevent tree mortality in high value stands in T4ND. We also recommend that as a part of the treatment, a thorough evaluation be made of spruce protection.

FPM will assist the PFD to plan data base needs for an integrated pest management plan for spruce budworm and spruce coneworm. FPM recommends that the 1985 biological evaluation concentrate on T4ND, T5ND and Indian Township where budworm populations increased in 1984. Finally, budworm pheromone trapping should be expanded to all Passamaquoddy ownerships in 1985.

INTRODUCTION

Biological evaluations conducted from 1981-1983 described forest conditions, spruce budworm (Choristoneura fumiferana (Clemens 1865)) activity and spray history for the Passamaquoddy lands (1,2,3). The Passamaquoddy Forestry Department (PFD) carried out spray projects in 1982-1984 based on the recommendations of these biological evaluations. Last year, the PFD treated 23,852 acres with Bt in Indian Township and Lowelltown-Holeb Townships (4).

This report summarizes the biological evaluation carried out in 1984. The report assesses and predicts trends in budworm and spruce coneworm (Dioryctria reniculelloides (Mutt. and Mon.)) populations, red spruce (Picea rubens Sens. Lat.) defoliation and stand conditions. The report also recommends possible actions to reduce future budworm damage.

METHODS

The hazard rating system used is described in Appendix 1. This system was developed for balsam fir but is used here for red spruce. Unfortunately, spruce responds to budworm differently than balsam fir, but it is the only hazard rating system currently available (5).

The PFD located potential sampling points in each parcel based on stand composition, stand value and accessibility. These sampling points will be used for future biological evaluations.

Pheromone traps were placed in T5ND locations from 1982-1984 as part of a pheromone monitoring special project. Traps were placed in late June and collected in early August. Branches were collected from these locations for egg mass searching as part of the pheromone project.

In all other locations, branches and stand information were collected in September and October 1984. The overwintering larval survey differentiated between spruce budworm and spruce coneworm.

PRESENT CONDITIONS

Indian Township

The overwintering larval survey found medium budworm and low coneworm population levels (Table 1). Light defoliation occurred in 1984 and is expected in 1985. Spruce hazard is moderate (Table 2).

T4ND

The overwintering larval survey found high budworm and medium coneworm population levels (Table 1). If budworm and coneworm counts are combined, then six of eight sample points have extreme population levels (Figure 1). Light defoliation occurred in 1984 but heavy to severe defoliation is expected in 1985. Spruce hazard is moderate (except sample point 7 where hazard is high) but at the upper end of the moderate class (Table 2, Figure 2).

T5ND

Medium budworm populations and low to medium coneworm populations occurred in the overwintering larval survey (Table 1). In contrast, the egg mass survey and pheromone trap catch found low 1984 budworm population (Table 2, Table 3). Light defoliation occurred in 1984 and is expected for 1985. Spruce hazard is moderate (Table 2).

T5R1

The overwintering larval survey found low to medium budworm and low coneworm population levels (Table 1). Light defoliation occurred in 1984 and is expected for 1985. Spruce hazard is moderate (Table 2).

Lowelltown-Holeb Townships

Both budworm and coneworm population levels are low (Table 1). Light defoliation occurred in 1984 and is expected in 1985. Spruce hazard is low to moderate and varies considerably between sampling points (Table 2).

Table 1. Overwintering budworm and coneworm larval counts per 100 square feet of foliage on Passamaquoddy lands in 1984.

Location	Budworm	Coneworm	Budworm and Coneworm	Combined Population Levels 1/
INDIAN TOWNSHIP				
1	174	23	197	Medium
2	332	48	380	Medium
3	252	167	419	Medium
4	248	131	379	Medium
5	446	179	625	High
T4ND				
1	62	99	161	Low
2	838	766	1604	Extreme
3	918	362	1280	Extreme
4	409	36	445	Medium
5	894	276	1170	Extreme
6	2037	264	2301	Extreme
7	1100	194	1294	Extreme
8	852	417	1269	Extreme
T5ND				
1	470	234	714	High
2	183	144	327	Medium
T5R1				
1	92	101	193	Medium
2	239	84	323	Medium
LOWELLTOWN-HOLEB TOWNSHIPS				
LT-1	33	20	53	Light
LT-2	367	35	402	Medium
LT-3	151	28	179	Medium
HLB-1	15	0	15	Light
HLB-2	30	10	40	Light

1/ Low 0 - 175
Medium 176 - 500
High 501 - 1100
Extreme 1100 +

Table 2. 1984 Hazard Ratings for Passamaquoddy lands.

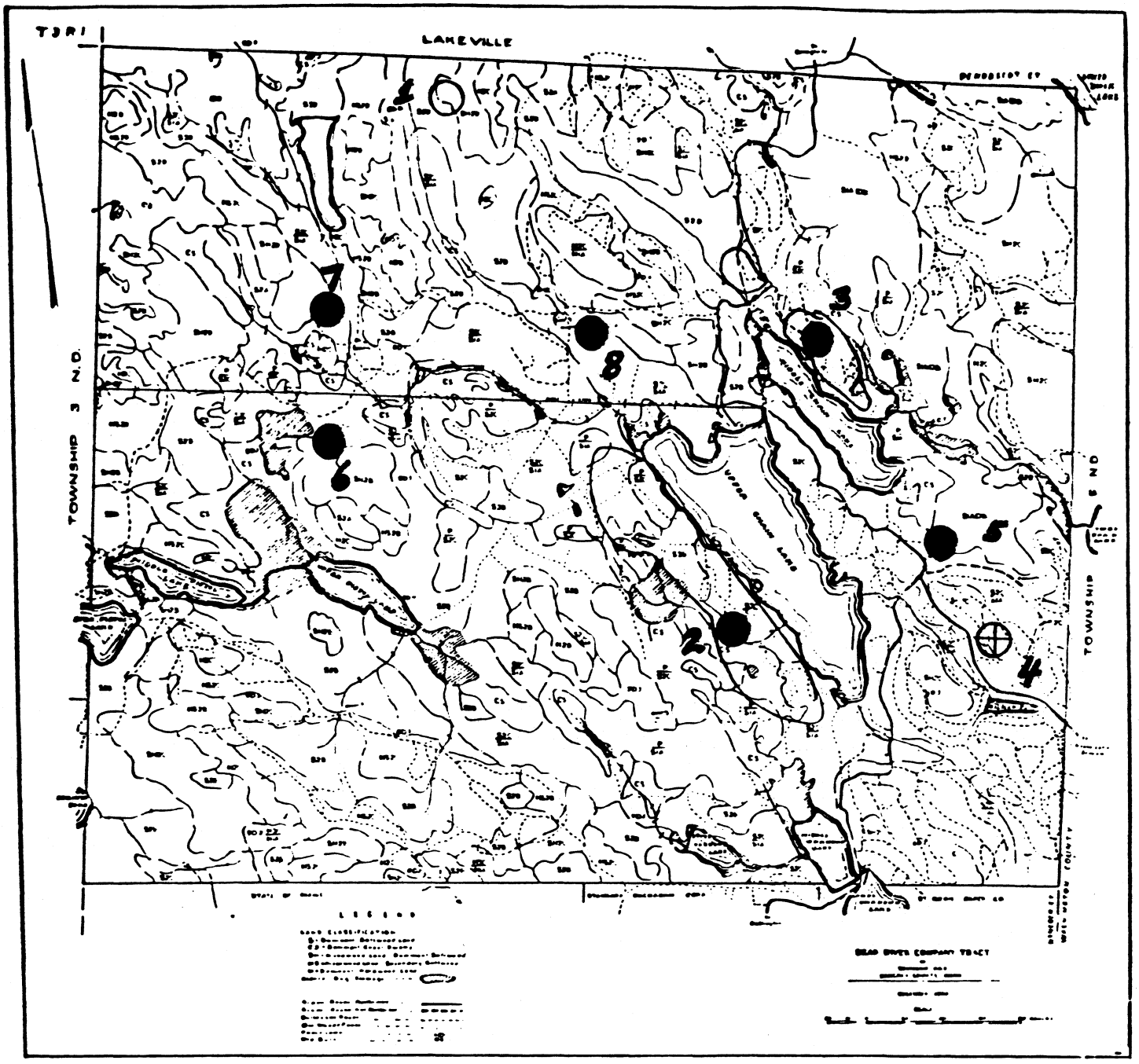
Location	L2/100 Ft[2]	Defoliation			Tree Vigor	Dead Tops	Hazard[1]/
		1982	1983	1984			
INDIAN TOWNSHIP							
1	174	10	30	50	Fair	+	12
2	332	10	20	50	Fair	+	13
3	252	10	20	60	Fair	+	13
4	248	10	10	40	Fair	+	13
5	446	10	20	60	Fair	+	13
T4ND							
1	62	10	20	40	Fair	+	12
2	838	10	20	50	Poor	+	15
3	918	10	30	40	Poor	+	15
4	409	10	20	50	Fair	+	13
5	894	10	20	60	Fair	+	14
6	2037	10	20	30	Fair	+	15
7	1100	10	30	40	Poor	+	16
8	852	10	20	50	Poor	+	15
T5ND							
1	470	10	20	30	Fair	+	13
2	183	10	20	40	Fair	-	10
3	14[2]/	20	30	50	Fair	-	9
4	71[2]/	10	20	30	Fair	+	12
5	68[2]/	10	20	40	Fair	-	9
6	39[2]/	10	30	39	Fair	-	9
T5R1							
1	92	10	10	30	Fair	+	9
2	239	10	10	40	Fair	+	13
LOWELLTOWN-HOLEB TOWNSHIPS							
LT-1	33	10	10	10	Good	-	5
LT-2	367	20	50	50	Fair	+	13
LT-3	151	10	10	30	Fair	+	9
HLB-1	15	10	30	30	Fair	+	12
HLB-2	30	10	10	10	Fair	-	6

1/ Hazard Rating — Range of Total Values

Low	0- 6
Moderate	7-15
High	16-22
Extreme	23-26

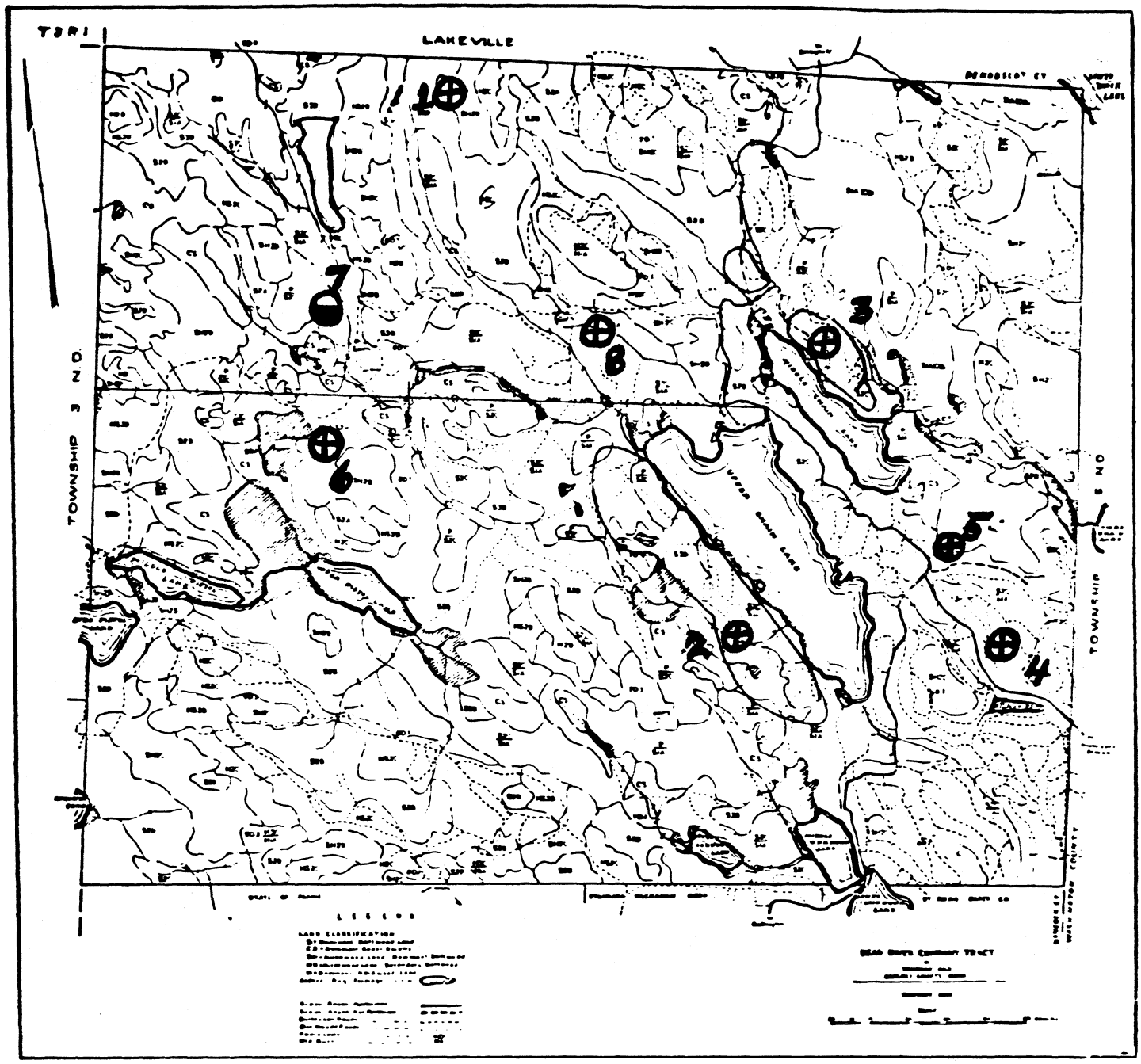
2/ Egg masses/100 sq.ft.

Figure 1. Overwintering budworm and coneworm larvae per 100 square feet of foliage at eight sample points in T4ND.



LEGEND:		Overwintering Larvae
	Low	0 - 175
	Medium	176 - 500
	High	501 - 1100
	Extreme	1100 +

Figure 2. Spruce hazard for eight sampling points in T4ND.



LEGEND:

Low	0 - 6	○
Moderate	7 - 15	⊕
High	16 - 22	◒
Extreme	23 - 26	●

POPULATION AND DEFOLIATION TRENDS

Indian Township

Budworm population levels were high in 1982 before decreasing to medium in 1983 and 1984 (Table 4). Defoliation has decreased from heavy in 1980 to moderate in 1981 and 1982 and finally to light in 1983 and 1984 (Table 5).

T4ND

Budworm population levels were high in 1982, overwintering larval populations were not surveyed in 1983, and 1984 population levels are again high and similar to 1982 levels (Table 4). Defoliation was moderate between 1980-1982 before decreasing to light in 1983 and 1984 (Table 5).

T5ND

Based on the overwintering larval survey, budworm population levels were high in 1982, they decreased to medium in 1983 before increasing slightly in 1984 (Table 4). The egg mass survey indicates a more volatile trend with extreme population levels in 1982 decreasing to low in 1983 and 1984 (Table 4). Pheromone trap catch has decreased every year between 1982-1984 (Table 3). Defoliation was moderate between 1980-1982 before decreasing to light in 1983 and 1984 (Table 5).

T5R1

Budworm population levels were high in 1982, overwintering larvae were not surveyed in 1983, and 1984 population levels were low (Table 4). Defoliation has been light between 1980-1984 except for 1981 when defoliation was moderate (Table 5).

Lowelltown-Holeb Townships

Budworm population levels were medium in 1983 and 1984 although 1984 levels averaged only 25 percent of 1983 levels (Table 4). Defoliation has been light and decreasing each year between 1982-1984 (Table 5).

Table 3. Average trap catch of budworm moths in T5ND.

Location	1982	1983	1984
Q1	30	36	17
Q3	32	7	3
Q5	14	8	2
Q6	27	18	3
$\bar{x}$	26	17	6

Table 4. Average numbers of overwintering larvae per 100 square feet of foliage on Passamaquoddy lands.

Location	1982	1983	1984
IT	537	284	315
T4ND	923	-	889
T5ND	962(576)[1]/	216(57)[1]/	326(48)[1]/
T5R1	519	-	166
Lowelltown/ Holeb	-	470	199

[1]/ Egg masses per 100 sq.ft. of foliage.

Table 5. Average percent spruce defoliation on Passamaquoddy lands. (Does not include reduction of foliage as a result of bud damage.)

Location	1980	1981	1982	1983	1984
IT	70	50	50	20	10
T4ND	45	60	40	22	10
T5ND	40	45	35	23	10
T5R1	30	40	30	10	10
Lowelltown/ Holeb	-	-	26	22	12

DISCUSSION

High budworm and coneworm population are expected in T4ND in 1985 that may cause heavy defoliation and possibly some tree mortality. In contrast, other locations should have low to medium budworm and coneworm population levels, light defoliation and little if any tree mortality occurring in 1985. Light 1985 defoliation should continue the trend of decreasing spruce defoliation established between 1980-1984 except for T4ND where heavy to severe 1985 defoliation is expected.

T4ND was treated with Bt in June 1983 and postspray larval and pupal survivors averaged less than one budworm per 18-inch branch in July 1983. Pheromone trapping in T5ND indicated that no mass moth flights occurred in the Springfield area in 1983. Therefore, it is likely that overwintering larval population levels were low in 1983 and increased dramatically in 1984. High population levels are widespread, occurring all around the Chain Lakes as well as north of the Pistol Lakes (Figure 1).

Recent research at the University of Maine at Orono indicates that spruce coneworm is an important defoliator of red spruce that can consume nearly as much food as budworm (5). As a result, future damage predictions for red spruce should account for both budworm and coneworm damage.

Based on traditional methods, we predict that extreme population levels may cause heavy to severe defoliation. However, our recent experiences on Indian lands from 1982-1984 indicate that budworm populations on spruce suffer high natural mortality and cause much less defoliation than expected. Maine and eastern Canada have had similar experiences. Recent observations show that protection with either chemical or biological insecticides is less effective on spruce compared to balsam fir (5).

Why has actual defoliation been so low compared to expected spruce defoliation, given high budworm population levels? One possible explanation is that, because of high natural budworm mortality, most larvae die before mining buds. If this happens, then a relatively large amount of current foliage would be produced on current shoots with fewer survivors to consume it. The result would be lower defoliation than expected from overwintering larval population levels.

A second explanation is that our evaluation tool is not accurately measuring spruce damage and underestimates spruce defoliation. The current technique (developed for balsam fir) measures defoliation of current shoots and does not account for the defoliation caused by buds mined and killed before elongation. Recently, bud mining is thought to be a major source of spruce defoliation compared to balsam fir, where defoliation of current foliage is important. Henry Trial (Maine Forest Service) estimates that 60-80 percent of spruce defoliation is from bud mining (personal communication, 1984). Underestimating spruce defoliation is particularly troubling with respect to the hazard rating system. This system was developed for balsam fir and defoliation of expanded shoots. If we underestimate current spruce defoliation, then we are surely underestimating past spruce defoliation. And, if defoliation is a major feature in determining tree vigor, then it can easily be overestimated.

This problem may explain why spruce trees appear to die so quickly because we cannot recognize the initial symptoms of declining spruce trees.

SUMMARY AND MANAGEMENT OPTIONS

Based on spruce budworm and spruce coneworm populations and traditional assessment of expected damage, we recommend treatment to prevent tree mortality in high value stands in T4ND. Recent information presented at the Red Spruce Protection Symposium (5) indicates that treatments may not be as effective as once believed. Therefore, we recommend that as a part of the 1985 treatment, a thorough evaluation be made of spruce protection. The evaluation should determine the extent of budmining and its contribution to spruce defoliation in treated and untreated areas. Tree mortality in treated and untreated stands should also be compared, beginning in 1985 and continuing for at least 5 years. A member of our staff will be available to help the PFD plan and carry out the evaluation.

Application of Bt undiluted at 12 BIU's per acre in a volume of 24 to 48 fl.oz. per acre is suggested, given the tribal policy to use biological insecticides. Use fixed wing or helicopters that can deliver small droplets (50-100 micrometers in diameter). Time treatment to early larval instars as soon as larvae switch from needle-mining to budmining and feeding.

Various silvicultural practices to reduce budworm damage were discussed in detail in the 1983 biological evaluation (3). Briefly, budworm damage will be influenced by rotation age, the balance of age classes present, species mix of budworm hosts and non-hosts, partial cutting to sustain sawtimber yields, abandoning and salvaging stands, and protecting foliage with insecticides.

The PFD has recently asked FPM to help plan data base needs for an inventory system. When this data base is acquired, an integrated pest management plan can be created for both budworm and coneworm. FPM will assist the PFD to begin this process in 1985.

The 1985 biological evaluation should focus on T4ND, T5ND and Indian Township where budworm populations increased in 1984. Also, pheromone trapping should be expanded in 1985 to include T4ND, T5R1, Indian Township and Lowelltown-Holeb Townships as well as T5ND.

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